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Quantitative excretion of renal tubular epithelial cells and erythrocytes in children and adolescents

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QUANTITATIVE EXCRETION OF RENAL TUBULAR EPITHELIAL CELLS AND ERYTHROCYTES IN CHILDREN AND ADOLESCENTS

By:

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WITH GRATEFUL APPRECIATION TO MY ADVISOR,

DR. CAROL ANGLE

Since 1965, considerable interest has developed concerning the role of analgesic abuse in chronic interstitial nephritis. Prescott and Brodie[1] studied the effects of therapeutic doses of acetylsalicylic acid, phenacetin, paracetamol, and caffeine on renal tubular exfoliation and red cell excretion in healthy adults.

It was first necessary for them to establish the normal excretion rates for renal tubular cells and red cells. These were their parameters for measuring the toxic effects of those compounds on the kidney tubules. Control rates varied from approximately 50,000 cells per hour to approximately 120,000 cells per hour. The mean rates of renal and red cell excretion calculated from their data were about 90,000 cells per hour and 24,100 cells per hour respectively.

Studies by Angle and Conley[2] of the effects of aspirin on the renal cell and red cell excretion rates in children showed the mean control excretion rates were 10,600 for renal cells and 8000 cells for erythrocytes. There is a significant difference in the excretion rates between adults and children in these two studies. It was decided to carry out an additional study in an attempt to determine what were the rates of renal and red cell excretion in presumably well children, comparing the effect of age, sex and race.

Thirty-two Negro children ranging in ages from three to six were the first group studied. These children were randomly selected from the Wirt Street Day Care Center, a preschool education center for Negro children. Timed urine samples were obtained from the eighteen girls and fourteen boys in the study on two different occasions.

The urine samples were examined usually within two hours after collection. The time representation of each sample, the volume of each sample were re-

corded. Labstix Reagent strips (R_x) were employed to determine the pH, and the existance of any occult blood, glucose, acetone or protein in the submitted samples. A differential stain (3) was then applied to the centrifuged sediment so the cellular constituents could be easily counted and identified. With the stain leucocytes stained deep blue-black, renal tubular cells and squamous epithelial cells appeared pink and erythrocytes were stained red. A Neubauer counting chamber was used to count the cells in the properly diluted specimen and the rates of excretion were then calculated.

The mean values of renal and red cell excretion per hour for the Negro group were 84,400 and 28,100 cells/hour respectively. These values were corrected by removing the highest and lowest values. The values thus obtained were a mean excretion rate of 74,500 renal cells per hour and 26,600 red cells per hour. These excretion rates were further corrected by removing from the data any of the individuals who exhibited proteinuria during the sampling and thus who might have an element of renal dysfunction. The mean values thus obtained were as follows: 70,500 renal cells per hour and 28,300 red cells per hour. The standard deviation for the renal excretion rate was 59,300 cells per hour and 22,900 cells per hour for the red cell excretion rate.

There was no significant difference in excretion rates of males and females. Although there is a significantly higher incidence of urinary tract infections among females, this group would be too small for analysis. One girl, of the eighteen tested, exhibited one episode of proteinuria whereas two of the fourteen boys each had one sample with protein.

The white cell excretion rates were too variable for conclusions to be drawn

or definite norms to be established. This is in accord with the observations of Prescott and Brodie.[1]

The height and weight of each child was recorded and there was no correlation with excretion rates of renal and red cells noted.

The next group of individuals studied were from the Christ Child Day Care Center in South Omaha. The children were white and were all four years old. Nine children were studied on two different occasions. The same procedure was used as with the Negro children. There were 6 males and 3 females in this study. None of these children showed any proteinuria during either testing period.

The mean values of renal and red cell excretion per hour for the entire group of white children were 76,720 and 42,379 cells per hour respectively. These values were also corrected by removing the highest and lowest values. Now the values were a mean excretion rate of 67,543 renal cells per hour and 37,506 red cells per hour. Since none of these children showed any proteinuria during the testing period none of the samples were removed because of proteinuria. There was no significant difference between excretion by white and Negro pre-school children, although analysis is limited by the size of our samples.

Comparison of the data with another study by Angle and Conley[4] of teen-age boys who were divided into Prepubescent, Pubescent and Postpubescent stages by the criteria used by Schonfeld,[5] showed no significant difference in the mean excretion rates for red cells and renal tubular epithelial cells. All groups fall well within the two standard deviation range of the original study group of Negro pre-schoolers. The lack of difference in adolescence suggests that there is no significant hormonal control of the excretion of these two cellular elements.

There is no significant difference in excretion rates between the sexes. These findings compare with those offered by Prescott who found no difference for age and sex in adults studied.

Twelve children in the Pediatric Renal Clinic with a variety of renal diseases were also investigated. The mean renal tubular cell excretion rate was 1,220,300 cells/hour and their mean red cell excretion as 263,500 cells per hour. Six of the twelve children excreted tubular cells in quantities well beyond two standard deviations of the control group and red cell excretion was significantly increased in four of the twelve patients. It should be noted that the mean rate of excretion, $\pm$ 2S.D., of red cells in normal patients, corrected for 24 hours, is 1.5-2.0 million, almost ten times the normal value of 130,000 rbc/24 hrs by Addis count (6). This difference is attributed to use of fresh, short term, ambulatory urine collections.

The high rates of excretion of renal tubular cells by patients with quiescent urinary tract infections in the absence of bacteriuria is most provocative, and suggests the potential value of such quantitative excretions as an index of interstitial nephritis that might be correlated with other parameters such as maximal urinary concentration, calyceal distortion, biopsy findings and historical duration of disease.

WIRT STREET DAY CARE CENTER

#	Name	Sex	Race	Test Tape Rx.	Renal Cells/hr	Red Cells/hr	Age
1.	B.H.	F	N	Neg. pH5	101,500	13,050	3
				Neg. pH5	77,600	12,933	
				Avg.	89,550	12,992	
2.	L.T.	F	N	Prot. tr. pH5	139,500	31,000	3
				Neg. pH5	31,954	9,399	
				Avg.	85,727	20,199	
3.	R.C.	F	N	Neg. pH7	35,150	18,500	3
				Neg. pH8	43,454	7,669	
				Avg.	39,302	13,084	
4.	S.S.	F	N	Neg. pH6	87,872	23,829	4
				Neg. pH6	172,000	48,166	
				Avg.	129,936	35,997	
5.	S.W.	F	N	Neg. pH7	19,600	5,600	4
				Neg. pH7	57,391	26,782	
				Avg.	38,495	16,191	
6.	R.M.	F	N	Neg. pH5	31,000	13,950	4
				Neg. pH6	411,600	184,800	
				Avg.	221,300	99,375	
7.	R.S.	F	N	Neg. pH5	14,466	2,800	4
				Neg. pH5	57,333	12,000	
				Avg.	35,899	7,400	

#	Name	Sex	Race	Test Tape Rx.	Renal Cells/hr	Red Cells/hr	Age
8.	A.W.	F	N	Neg. pH7	35,139	15,277	3
				Neg. pH5	52,800	21,600	
				Avg.	43,969	18,438	
9.	F.J.	M	N	Neg. pH8	43,164	11,138	4
				Neg. pH5	85,444	27,840	
				Avg.	64,304	19,489	
10.	B.D.	M	N	Prot. tr pH7	50,000	33,000	3
				Neg. pH5	32,690	13,076	
				Avg.	41,345	23,038	
11.	D.S.	M	N	Neg. pH5	7,500	2,500	3
				Neg. pH5	28,800	12,000	
				Avg.	18,150	7,250	
12.	R.T.	M	N	Neg. pH5	322,907	178,970	4
				Neg. pH5	48,000	21,333	
				Avg.	185,453	99,751	
13.	L.H.	M	N	Neg. pH5	45,600	27,360	5
				Neg. pH7	43,200	16,000	
				Avg.	44,400	21,680	
14.	M.W.	M	N	Neg. pH5	36,000	14,400	5
				Prot. tr. pHt	147,200	46,000	
				Avg.	91,600	30,200	
15.	V.S.	F	N	Neg. pH5	140,000	42,000	4
				Neg. pH5	159,428	72,000	
				Avg.	149,714	57,000	

#	Name	Sex	Race	Test Tape Rx		Renal Cells/hr	Red Cells/hr	Age
16.	B.W.	F	N	Neg. pH7		32,400	10,800	3
				Neg. pH5		32,000	15,200	
					Avg.	32,200	13,000	
17.	T.H.	F	N	Neg. pH7		63,999	21,333	4
				Neg. pH8		109,333	25,511	
					Avg.	86,666	28,888	
18.	B.W.	F.	N	Neg. pH6		208,000	97,600	4
				Neg. pH5		26,633	15,666	
					Avg.	117,317	31,200	
19.	D.D.	M	N	Neg. pH5		49,400	31,200	5
				Neg. pH5		83,200	32,688	
					Avg.	66,300	31,944	
20.	D.D.	M	N	Neg. pH5		19,571	8,228	5
				Neg. pH5		28,200	9,400	
					Avg.	23,885	8,814	
21.	J.P.	F	N	Neg. pH7		7,428	4,000	4
				Neg. pH7		42,311	39,822	
					Avg.	24,869	21,911	
22.	F.W.	F	N	Neg. pH7		40,000	10,000	4
				Neg. pH7		31,000	21,000	
					Avg.	35,750	15,500	
23.	K.S.	M	N	Neg. pH8		16,600	5,000	6
				Neg. pH7		22,500	4,166	
					Avg.	19,250	4,583	

#	Name	Sex	Race	Test Tape Rx.	Renal Cells/hr	Red Cells/hr	Age
24.	R.N.	M	N	Neg. pH 5	64,533	16,133	4
				Neg. pH 5	50,105	23,578	
				Avg.	57,319	19,855	
25.	H.H.	M	N	Neg. pH 7	24,000	7,500	3
				Neg. pH 5	16,714	5,571	
				Avg.	20,357	6,535	
26.	Q.M	M	N	Neg. pH 7	39,200	14,700	4
				Neg. pH 5	38,666	9,333	
				Avg.	38,933	12,016	
27.	D.T.	M	N	Neg. pH 7	23,703	7,183	3
				Neg. pH 7	24,000	17,600	
				Avg.	23,852	12,392	
28.	N.B.	F	N	Neg. pH 5	291,333	53,200	5
				Neg. pH 7	144,480	48,800	
				Avg.	217,906	51,000	
29.	T.N.	F	N	Neg. pH 7	105,000	9,000	5
				Neg. pH5	59,533	28,200	
				Avg.	82,266	18,600	
30.	F.B.	F	N	Neg. pH 5	725,800	76,000	5
				Neg. pH 5	168,000	47,040	
				Avg.	446,900	61,520	
31.	S.W.	F.	N	Neg. pH 8	43,520	27,200	4
				Neg. pH 5	166,080	104,400	
				Avg.	104,800	65,800	

#	Name	Sex	Race	Test Tape Rx	Renal cells/hr	Red cells/hr	Age
32.	T.M.	M	N	Neg. pH 5	23,000	9,000	5
				Neg. pH 5	23,233	8,200	5
				Avg.	23,116	9,800	

CHRIST CHILD DAY CARE CENTER

#	Name	Sex	Race	Test Tape Rx	Renal Cells/hr	Red Cells/hr	Age
1.	L.A.C.	F	W	Neg. pH 5	56,875	26,870	4½
	1/27/64			Neg. pH 5	43,200	12,330	
				Avg.	50,038	19,600	
2.	7/31/64	M	W	Neg. pH 7	27,122	15,250	4
				Neg. pH 6	30,200	6,550	
				Avg.	28,660	10,900	
3.	A.M.	F	W	Neg. pH 5	21,000	24,125	4
	6/6/64			Neg. pH5	8,750	30,180	4
				Avg.	19,875	27,252	
4.	D.G.	M	W	Neg. pH 5	30,400	22,000	4
	10/7/64			Neg. pH 5	22,870	5,670	
				Avg.	26,635	13,835	
5.	K.K.	M	W	Neg. pH 7	87,500	57,550	4
	10/20/64			Neg. pH 6	94,350	22,870	
				Avg.	90,925	40,210	
6.	5/17/64	F	W	Neg. pH 5	141,450	116,150	4
				Neg. pH 5	96,800	98,400	
				Avg.	119,125	107,270	
7.	9/30/64	M	W	Neg. pH 5	153,333	109,200	4
				Neg. pH 5	187,483	86,480	
				Avg.	170,408	97,840	

#	Name	Sex	Race	Test Tape Rx	Renal Cells/hr	Red Cells/hr	Age
8.	4/5/64	M	W	Neg. pH 5	77,720	34,466	4
				Neg. pH 5	30,120	8,760	
				Avg.	53,420	21,613	
9.	C.S.	M	W	Neg. pH 6	121,600	45,600	4
	5/30/64			Neg. pH 5	100,400	40,390	
				Avg.	111,000	42,990	

OMAHA HOME FOR BOYS

#	Name	Pubescent State	Age	Renal Cells per hour	Red Cells per hour	Test Tape
1.	S.M.	Post Pubescence	17	149,364	136,376	pH5 (Pr.tr)
2.	G.F.	Pubescence	16	69,277	21,500	pH5 Neg.
3.	J.C.	Post Pubescence	17	115,500	63,000	pH5 Neg.
4.	R.R.	Post Pubescence	17	95,666	44,977	pH5 Neg.
5.	D.B.	Pubescence	17	54,264	18,088	pH5 Neg.
6.	J.L.	Pubescence	16	68,900	20,874	pH5 Neg.
7.	J.H.	Post Pubescence	16	48,484	23,273	pH5 Neg.
8.	R.H.	Post Pubescence	18	36,923	14,505	pH5 Neg.
9.	A.A.	Post Pubescence	17	137,500	58,928	pH5 Neg.
10.	B.H.	Post Pubescence	19	61,875	73,333	pH5 Neg.
11.	T.S.	Pubescence	15	63,978	31,989	pH5 Neg.
12.	S.O.	Pubescence	16	42,696	24,019	pH5 Neg.
13.	G.H.	Post Pubescence	17	59,825	31,337	pH5 Neg.
14.	M.T.	Post Pubescence	17	95,768	36,117	pH5 Neg.
15.	N.H.	Post Pubescence	18	115,057	52,912	pH5 (Pr.tr)
16.	R.D.	Pubescence	17	63,424	36,666	pH5 Neg.
17.	C.R.	Pubescence	15	79,146	18,264	pH5 Neg.
18.	A.W.	Pubescence	15	70,505	38,372	pH6 Neg.
19.	L.B.	Pubescence	17	64,038	22,500	pH5 Neg.
20.	E.S.	Pubescence	15	93,447	28,210	pH5 Neg.
21.	T.C.	Pubescence	15	26,785	10,714	pH5 Neg.

#	Name	Pubescent State	Age	Renal Cells per hour	Red Cells per hour	Test Tape
22.	D.W.	Pubescence	16	112,875	48,375	pH5 Neg.
23.	D.U.	Post Pubescence	15	90,795	21,363	pH5 (Pr. tr)
24.	R.B.	Post Pubescence	16	82,600	47,200	pH5 Neg.
25.	H.J.	Post Pubescence	17	26,810	20,624	pH5 Neg.
26.	D.C.	Pubescence	15	60,500	57,475	pH5 Neg.
27.	R.S.	Pubescence	15	29,381	20,987	pH6 Neg.
28.	R.S.	Post Pubescence	14	51,246	28,470	pH5 Neg.
29.	B.M.	Pubescence	13	45,312	32,366	pH5 Neg.
30.	J.S.	Pubescence	13	43,750	15,625	pH5 Neg.
31.	S.G.	Pubescence	14	163,636	306,818	pH5 Neg.
32.	K.C.	Pubescence	13	40,187	18,658	pH5 Neg.
33.	L.B.	Pubescence	14	36,406	25,108	pH6 Neg.
34.	J.S.	Pubescence	15	31,138	13,111	pH5 Neg.
35.	J.B.	Post Pubescence	16	36,016	30,329	pH5 Neg.
36.	D.L.	Pubescence	15	45,598	20,109	pH5 Neg.
37.	C.S.	Pubescence	14	23,000	15,333	pH5 Neg.
38.	W.H.	Pre-Pubescence	13	45,000	20,000	pH5 Neg.
39.	R.N.	Pubescence	14	50,000	33,333	pH5 Neg.
40.	R.W.	Pubescence	14	63,472	36,746	pH5 Neg.
41.	D.F.	Pre-pubescence	12	26,521	38,125	pH5 Neg.
42.	K.S.	Pre-pubescence	13	30,362	25,568	pH5 Neg.
43.	J.N.	Pre-pubescence	12	39,389	18,381	pH5 Neg.

#	Name	Pubescent State	Age	Renal Cells per hour	Red Cells per hour	Test Tape
44.	R.P.	Pubescence	14	66,251	28,393	pH5 Neg.
45.	G.D.	Pre-pubescence	12	30,684	19,526	pH5 Neg.
46.	L.T.	Pubescence	13	59,838	39,881	pH5 Neg.
47.	D.D.	Pubescent	13	26,442	13,750	pH6 Neg.
48.	J.M.	Pubescent	14	58,032	30,222	pH5 Neg.
49.	R.S.	Pubescent	13	46,262	29,218	pH5 Neg.
50.	J.L.	Pre-pubescent	12	31,720	19,032	pH5 Neg.
51.	D.J.	Pre-pubescent	11	27,536	17,701	pH5 Neg.
52.	R.R.	Pubescent	12	68,810	100,123	pH5 Neg.
53.	D.T.	Pubescent	13	52,688	42,150	pH5 Neg.

PEDIATRIC RENAL CLINIC

#	Name	Sex	Age	Diagnosis	Renal Cells per hour	Red Cells per hour	C &S	Colony Count
1.	L.W.	F	12	Nephritis Follow-up	772,000	260,000	Gm neg. rods Non hem. staph.	24,000/ml
2.	S.R.	F	6	Sol.Cyst of Kidney	50,000	61,000	Non hem. staph. Gm neg rod sp	9,000/ml
3.	K.M.	M	6	Polyuria	715,909	238,636	No growth	
4.	S.H.	M	15	Urethral Stenosis	44,000	14,000	Non hem. strep.	None performed
5.	S.N.	F	9	Recurrent Cystitis	25,875	11,250	No growth	
6.	D.P.	F	8	Urethral Stenosis	42,966	24,533	No growth	
7.	R.K.	M	12	Chronic Pyelo	48,000	12,000	No growth	
8.	L.S.	M	14	Membranous Nephritis	2,925,714	45,714	Non hem. Staph	1000/ml
9.	C.K.	F	9	Recurrent Pyelo	676,800	129,600	Hemol. Staph.	400/ml
10.	R.K.	M	12	Recurrent Pyelo	116,000	32,000	No growth	
11.	T.H.	M	3	Recurrent Cystitis	2,880,000	1,480,000	Gm. Neg. Rod sp.	10,000/ml
12.	W.M.	M	4	Polycystic Kidneys	5,176,470	647,058	No growth	

Mean Renal Tubular Cell Excretion= 1,220,300 cells/hr.

Mean Red Cell Excretion = 263,500 cells/hr.

RESULTS

Group Studied	Renal Cells/hr corrected mean values	Red cells/hr
Negro Children	70,500	28,300
White Children	67,543	37,506
Prepubescent Boys	31,100	23,800
Pubescent Boys	52,300	26,500
Post Pubescent Boys	79,000	40,200

FOOTNOTES

1. Prescott, L.F., Effects of Acetylsalicylic Acid, Phenacetin, Paracetamol and Caffeine on Renal Tubular Epithelium, Lancet 2:91, 1965

2. Angle, Carol, McIntire, Matilda, and Conley, Dean: Effect of Salicylates on Renal Tubular Epithelial Cell Excretion in Children, Presented Am. Association Poison Control Centers, Chicago, October, 1966

3. Prescott, L.F. and Brodie, D.E., A Simple Differential Stain for Urinary Sediment, Lancet 2: 940, 1964

4. Angle, Carol, McIntire, Matilda, and Conley, Dean: Renal Cell Excretion in Teen-age Boys. Unpublished Data 1966

5. Schonfeld, W.A. Table of Classification of Puberal Development, Am. Journal Dis. Child, 65: 535, 1943

6. Lippman, R.W., Urine and the Urinary Sediment, 2nd Edition, Charles C. Thomas, Springfield, Illinois 1962, p. 106

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